

THE LIZARD GENUS
APRASIA;
ITS TAXONOMY AND TEMPERATURE-
CORRELATED VARIATION

BY
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Pp. 363-385; 7 *Text-figures*

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SYNOPSIS

The genus *Ophioseps* cannot be maintained; its past recognition was due to errors of identification and observation. *Aprasia* is the most completely adapted of the Pygopodidae for fossorial life, the family exhibiting a continuous series in degeneration of limbs and girdles, with the development of a serpentiform habitus and cranial modifications for burrowing. There are three species with a combined range from Victoria to the Monte Bello Islands but which occur together in only a restricted area near Albany. Two of the species show a considerable range of variation in the numbers of presacral vertebrae and scales. This variation appears to be correlated with differing summer temperatures. Since the characters are meristic and such characters have been shown, in other cold-blooded animals, to be directly affected by the temperature prevailing during embryological development, it is suggested that the variation may prove to be thermoplastic. The other taxonomically useful, but non-meristic, characters show no significant variation in different climatic regions. The temperature correlated clines are discontinuous geographically, permitting recognition of two new subspecies.

Two small limbless lizards were collected on Hermite Island, one of the Monte Bello group, in 1952. They differ from any of the known species of the genus *Aprasia* but most nearly resemble *Aprasia repens* Fry. Since the Monte Bello Islands are geographically far removed from the recorded range of any species of *Aprasia* a re-survey of the known species of the genus, and its alleged ally *Ophioseps*, was necessary to ascertain the probable significance of the differences. More than 120 specimens were assembled for comparison, and this series covered not only the whole of the previously known geographical range, but included recently captured specimens from regions where none of these lizards had previously been reported.

MORPHOLOGY AND COMPOSITION OF THE GENUS

As will be demonstrated presently the series is subdivisible into five groups with morphological differences, but all the specimens share the following characters:

Scales smooth, subequal dorsally and ventrally except on the throat and pectoral region, where they are slightly smaller than on the belly; 12 or 14 longitudinal rows of scales at mid-body. General habitus worm-like, the head and tail not being wider or narrower than the body, which is very elongate and cylindrical. The snout projects in front of the labial margin and the large rostral shield is visible

from above ; five supralabials, the first being wholly or partly fused with a large nasal shield, which forms a suture with its fellow behind the rostral ; pre-frontals large, forming a median suture and in contact with the second labial ; a small pre-ocular in contact with the third labial and the supra-ocular, which reaches the fourth supra-labial or is separated from it by a single small post-ocular ; frontal hexagonal ; parietals not much larger than the scales of the occiput and nape, not in contact behind the frontal. Eye covered by a circular brill edged with a ring of small granules. Shields and scales of the head beset with numerous minute pustules, presumably tactile sense-organs. No external auditory meatus, tympanum or tympanic cavity. No vestiges of fore-limbs externally ; hind-limbs visible as small triangular flaps at the lateral corners of the vent, each being covered by a single triangular scale not very different in size or appearance from the other scales of the region. No pre-anal pores. A pair of post-anal sacs close behind the vent and opening by a pair of small pores just within its posterior border. Bordering the anterior margin of each of these sacs there is, in males, a post-cloacal bone which pierces the skin laterally close, but caudomesial, to the hind-limb vestige ; the protruding portion is sometimes claw-shaped, with the free terminal part of the claw directed postero-dorsally, or sometimes subcircular in surface view (Text-fig. 1).

The skull of *Aprasia repens* has recently been figured by McDowell & Bogert (1954, fig. 21) and specimens of all the species represented in the present material (*vide infra*) have been found to conform to this pattern. There is a single pre-

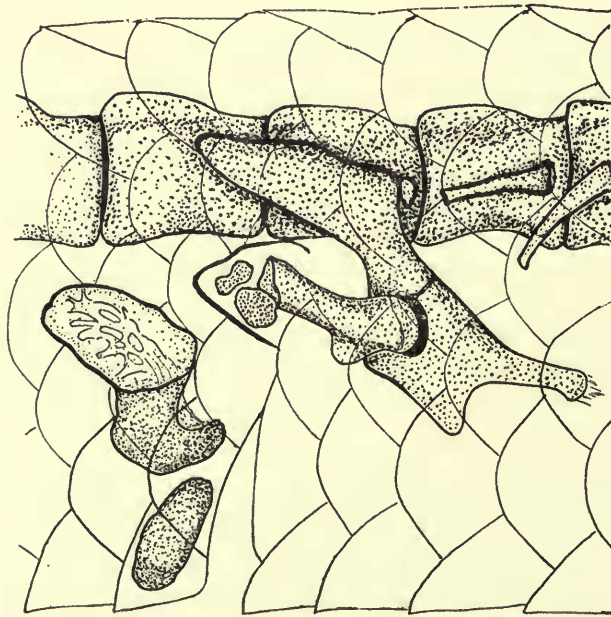


FIG. 1. Pelvic region of a cleared specimen seen in three-quarters ventro-lateral view from the right side to show hind limb, girdle and post-cloacal bones. (*Aprasia striolata*, ♂.)

maxilla ; paired nasals form a long median suture ; the prefrontals are separated mesially and extend posteriorly above the orbit to form a suture with a small post-frontal ; the frontals are fused to form a single median element, but the parietals are paired, forming a long median suture ; there is a narrow supra temporal (tabular).¹ In both sexes the maxillary is edentulous and the dentary is toothed ; the premaxilla is toothed in adult males of all species, but is completely edentulous in juveniles of all species and also in females, except in *A. striolata* where vestigial teeth may be present. In the lower jaw the splenial is wanting or is fused with the prearticular. The only skull examined that deviates in any way from this pattern is the one figured and described by Jensen (1901) as *Ophioseps nasutus* Bocage. This description has been the cause of much confusion. The lizard was incorrectly identified and the description is incorrect in many points that subsequent authors have accepted as indicating the existence of a genus (*Ophioseps* or *Ophioseps*) distinct from *Aprasia*. As will be demonstrated presently (p. 380), the type specimens of the type species of *Aprasia* Gray and *Ophioseps* Bocage are conspecific and the two names are thus strict synonyms. But even apart from this nomenclatorial consideration there appear to be no grounds for the recognition of a second genus. Jensen's specimens have been compared with a series of others from the same geographical area (Victoria and S. Australia) and have been found to be juveniles of the one and only species that occurs there. This, in its adult phase, has a skull like that described above. Jensen was in error in several respects, notably in regard to the frontals, prefrontals, postfrontals and "squamosal" (supratemporal) which, despite the immaturity of the skull, do not differ from those of the adult. He was also misled by the absence of any median suture between the parietals into believing that these bones were completely fused ; in fact, owing to immaturity, the development of the parietals is incomplete, but they exist as two very thin lateral blades widely separated on the mid-line.

Although all the species and subspecies examined have skulls that are essentially similar in their general structure, there will undoubtedly be found to be specific differences and, perhaps, ontogenetic differences in proportion. Insufficient skeletal material is available to the writer to permit of any definite conclusions, but in the long-snouted species (*A. repens*) the pre-orbital increase in length is accompanied by an increase in length of the nasals. Thus, the ratio of frontal to nasal length was found to be approximately 1.24 (c.f. also Bogert & McDowell's figure where the ratio is 1.25) in this species, but 1.40-1.49 in specimens from South Australia (*A. striolata*) and 1.50-1.56 in an example of *Aprasia pulchella* and the holotype of *Ophioseps nasutus* Bocage.

Other skeletal features of the series are as follows. Presacral vertebrae 88-137, the number varying from species to species ; the first three vertebrae (four in one specimen) lack ribs ; sacral vertebrae three, with sacral ribs diminishing in length caudad, the anterior two being free and the last knob-like and fused to the centrum (Text-fig. 2). Shoulder girdle a V-shaped structure composed of a pair of rod-like

¹ McDowell & Bogert (1954) figure this bone in their dorsal and ventral views (figs. 21A and B) but do not label it ; it is not shown in the lateral view (fig. 21C).

coracoids connected across the mid-ventral line by a V-shaped sternal cartilage. Each coracoid, which is slightly expanded at its ends, runs antero-dorsally from the sternum to a point near the distal extremity of the first rib. The dorsal end of each is tipped with a short, tapering length of cartilage which may represent a scapula. There are no traces of any bones of the fore-limb.

The pelvis (Text-figs. 1 and 2) consists of a subtriangular, slightly curled ilium and an ischiopubis. The ilium articulates at its postero-dorsal corner with the

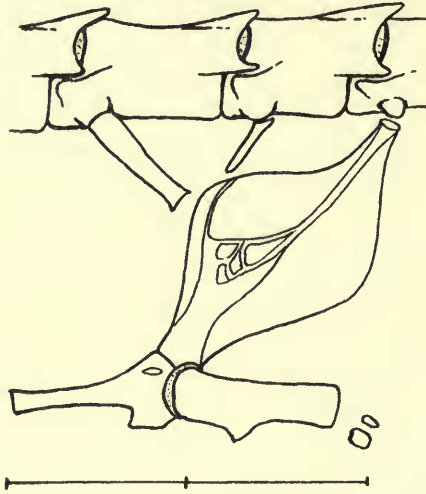


FIG. 2. *Aprasia striolata striolata*. Left pelvis and hind limb of a male, diagrammatic to show sacral connexions.

third, knob-like, sacral rib and the other two sacral ribs have loose ligamentous connexions with its antero-dorsal border. The ischium and pubis are fused, the ischiadic portion of the combined bone being rectangular and the pubic portion rod-like; both portions are widely separated from their fellows on the mid-ventral line. The hind limb consists of a short, stout femur, with a well-developed trochanter, and a nodule-like vestige of a tibia; sometimes there is also a vestigial fibula.

POSITION IN THE FAMILY PYGOPODIDAE

The various forms possessing these characters in common are clearly a closely related group and this position is best expressed taxonomically by treating them as a single genus. McDowell & Bogert (1954) in discussing the relationships of the family Pygopodidae have pointed out that "the more typical pygopods, the Pygopodinae and Lialinae" are akin to the geckoes in many features. But Jensen's account of *Ophioseps* misled them and, although they do not commit themselves definitely, they say "we see no reason to question Jensen's placing of *Ophioseps* in a distinct family, as Boulenger (1885) suggested. It is probable, however, that *Aprasia* should be transferred to the Ophiosepidae." Since *Ophioseps*, *sensu* Jensen, is a fallacy any such disposal of *Aprasia* would be absurd and it remains

to consider its position in relation to the other genera of the Pygopodidae. It shares with *Pygopus*, *Paradelma*, *Delma* and *Lialis* a unique character, a pair of post-cloacal bones forming external hooks as a secondary sex character of the male. These structures were first described and figured in 1870 by Fürbringer in *Lialis* (*burtoni*) but without the realization that they were associated with sex; the same author also described the limbs and girdles of *Pygopus*, but found no such structures because, presumably, his specimen was a female. Boulenger (1885: 239) mentioned, as a family character, the presence of a spur laterally behind the vent, but wrongly described it as a projection of the ischium and did not, apparently, observe that it was only present in the one sex. Kinghorn (1923: 134), alone, seems to have observed that in *Aprasia* the spurs are present in males only. The present writer has confirmed that they are, likewise, secondary sex characters of the male in the other four genera mentioned above.

Post-cloacal bones occur in male geckoes (Smith, 1933: 9), a fact taken into consideration, with others, by McDowell & Bogert in aligning the Pygopodinae and Lialinae with the Gekkota; but it seems unlikely that development of these bones to form external hooks would have occurred twice in Australasia, and nowhere else, *pari passu* with reduction of limbs, the acquisition of a serpentiform habit and sundry other features. So the position of *Aprasia* in the Pygopodidae seems assured. Within this family it is unique in its reduced dentition, degenerate eye, absent tympanum, rudimentary middle ear (Shute & Bellairs, 1953), the lack of a splenial bone (McDowell & Bogert, fig. 21) and vestigial shoulder girdle; the latter is much more complete in both *Pygopus* and *Lialis* (Fürbringer, 1870: pl. i, figs. 5, 6: Kinghorn, 1926). It differs from *Lialis* in its paired parietal bones and resembles *Pygopus*, *Paradelma*, *Delma* and *Pletholax* in this respect. If, therefore, subdivision of the Pygopodidae into subfamilies is desirable, there would be justification for placing *Aprasia* in a distinct subfamily by itself. This procedure would, however, tend to obscure the fact that the genera *Pygopus*, *Paradelma*, *Delma* and *Aprasia* form an almost continuous linear series showing progressive limb-reduction and shortening and consolidation of the skull. *Aprasia* is the most completely "degenerate" of the series as it is also, probably, the most truly fossorial.

SPECIES, RACES AND VARIATION

As already mentioned, the material examined is divisible into five morphological groups which form a rational geographical picture, briefly as follows:

I. A postocular shield present.

(a) Snout prominent (fig. 3A), 1.5 to 2.1 times as long as the eye.¹ A suture normally runs from the nostril to the second labial, the nasal and second labial shields being in contact.

(1) Presacral vertebrae 95-110 (mean 101.4). Mid-body scale rows 12 or 14. Victoria, South Australia, Nurina (W.A.).

(1) *Aprasia striolata striolata*.

(2) Presacral vertebrae 88-94 (mean 91.8). Mid-body scale rows 12. Albany, Plantagenet and Tambellup (W.A.).

(2) *Aprasia striolata glauerti*.

¹ The method of measurement is important and is discussed below (p. 375).

- (b) Snout less prominent (Text-figs. 3B and 6), 1.1 to 1.8 times as long as the eye. No suture running from the nostril. Presacral vertebrae 98-110 (mean 98.5) in males and 102-105 (mean 103.5) in females. Mid-body scale rows 14. Albany to Geraldton (W.A.): ? Northern Territory.

(3) *Aprasia pulchella*.

II. No postocular shield. Snout very prominent, 1.4 to 2.5 times as long as the eye (Text-figs. 3C and 7). A suture from the nostril reaches the prefrontal so that the nasal and second labial shields are not in contact or meet at a point only.

- (a) Presacral vertebrae 96-112 (mean 102.8) in males and 98-116 (mean 108) in females. Mid-body scale rows 12 (rarely 14). Albany to Shark Bay (W.A.).

(4) *Aprasia repens repens*.

- (b) Presacral vertebrae 125, male and 137, female. Mid-body scale rows 14. Hermite Island (W.A.).

(5) *Aprasia repens rostrata*.

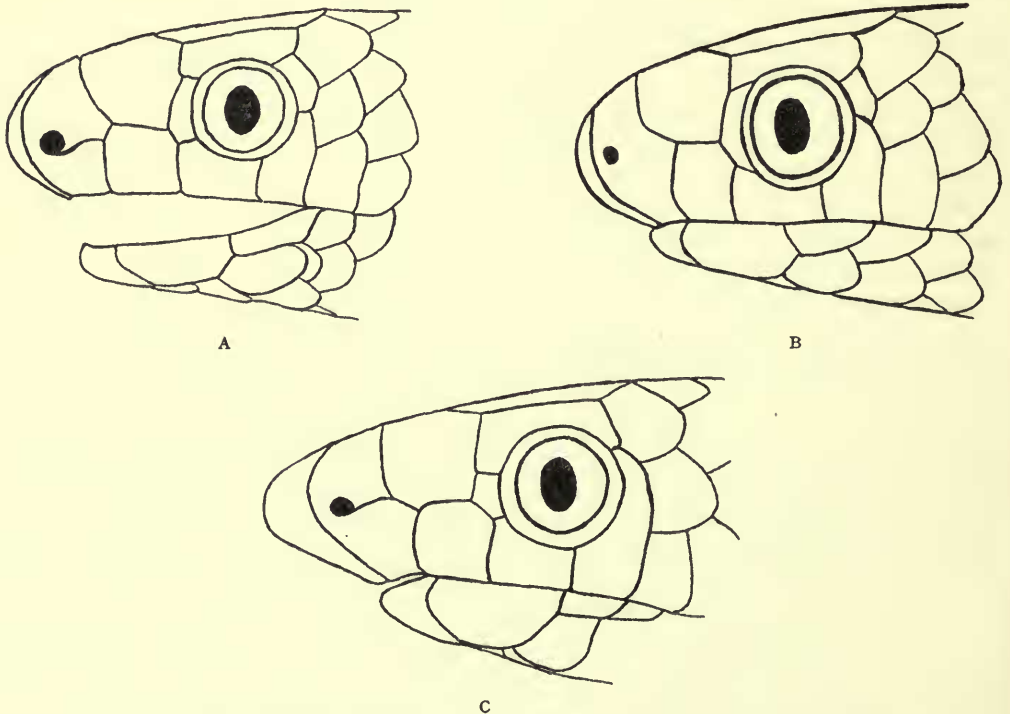


FIG. 3. Three male specimens of *Aprasia* from Albany, to show lateral head scales and proportions. A. *Aprasia striolata glauerti* subsp. nov. Holotype. B. *Aprasia pulchella* Gray. Perth Mus. 10955. C. *Aprasia repens repens* (Fry). Perth Mus. 10953.

In this synopsis the assemblages have been given specific or subspecific status and justification of these treatments is called for. It will be observed that many of the characters used in the key "break down" if they are considered without reference to geographical distribution. For instance, mid-body scale rows and

numbers of presacral vertebrae show a total range of variation which permits of no absolute differentiation between what are labelled as "species", thus :

	<i>A. striolata.</i>	<i>A. pulchella.</i>	<i>A. repens.</i>
Scale rows . . .	12-14	14	12-14
Vertebrae . . .	88-110	98-110	96-137

If, however, these characters are considered only in the geographical region where the three are sympatric, i.e. the Plantagenet Division of Western Australia, they provide in combination a clear cut differentiation, thus :

	<i>A. striolata.</i>	<i>A. pulchella.</i>	<i>A. repens.</i>
Scale rows . . .	12	14	12
Vertebrae . . .	88-94	98-103	96-106

A. pulchella is, additionally, completely differentiated from both of the others by its much less prominent snout with its less extensive rostral (less than one-third the diameter of the eye), the complete fusion of the nostril and first upper labial, and a distinctive colour pattern. Additional differences between *A. striolata glauerti* and *A. repens repens* exist in the same three features, viz.: Eye/rostral ratio 1.5-1.9 in *glauerti* vice 1.2-1.7 in *repens*, the suture behind the nostril running to the second labial in *glauerti* but to the prefrontal in *repens* and in colour. They are also completely differentiated by the post-ocular condition. Thus, the *Aprasias* of the Plantagenet Division can be subdivided into three different and distinct morphological groups which are not associated with age, sex, season, etc. It is reasonable to suppose that this fact signifies that there are three non-interbreeding assemblages and the only logical taxonomic treatment is to regard them as three distinct species. The most distinct morphologically is *A. pulchella* and this is also the species with the smallest geographical range (from Albany to Geraldton) and with the least variability. *A. repens* and *A. striolata* resemble each other more than either does *A. pulchella* and both show geographical variation of the same nature.

A. repens ranges northwards from Albany to the Monte Bello Islands and its distribution along this range may prove to be continuous, though the samples examined are not. The list of specimens examined, on pp. 382-383, is arranged in approximately south-north order, and it will be observed that, when due allowance is made for sexual and individual variation, there is a progressive increase in the number of presacral vertebrae from south to north; there is also an increase in the number of mid-body scale rows from 12 to 14. It is, however, clear that the variation is not exactly correlated with latitude. For instance, in a series of sixteen males from Perth and its environs the vertebral range is from 95 to 108, whereas in a series from around Northam in almost the same latitude the range is noticeably higher, from 108 to 112. This and similar discrepancies may be due to chance and the short series available, but it seems at least equally possible that some environmental, possibly climatic, factor is involved. Although there is an overall increase in temperature from south to north, the isotherms do not follow an east-west course;

Northam has a more "continental" climate than Perth with higher temperatures in summer, when the isotherms are locally almost parallel with the coast (c.f. *Year Book of Australia*, 40, 1954, p. 33). Rainfall, too, though generally decreasing with decreasing latitude, also diminishes with distance from the coast. Unfortunately climatological information is not available for many of the localities from which specimens have been examined, and in any event the series are often very short. But if localities are grouped into regions around climatological stations it is possible to test, roughly, for correlation. The following table shows such groupings in relation to the six stations named. No climatic data being available for the Monte Bello Islands, the temperature and rainfall figures of Onslow have been used.

Station.	Vertebrae.		Scales.	Rainfall (annual average) (in.).	Temperature (mean December) (° F.).
	♂.	♀.			
Albany . . .	96.0 (2)	—	12 .	39.7 .	64.2
Katanning . . .	97.3 (3)	104.4 (8)	12 .	19.4 .	68.3
Collie . . .	—	103.0 (2)	12 .	39.6 .	68.1
Perth . . .	102.6 (20)	108.6 (25)	12 .	36.0 .	71.0
Geraldton . . .	107.0 (2)	112.0 (1)	12/14 .	18.6 .	72.7
York . . .	110.7 (3)	111.0 (2)	12 .	18.0 .	73.5
Hermite Is. (Onslow) . . .	125.0 (1)	137.0 (1)	14 .	— .	—
	—	—	— .	9.4 .	83.0

There is no obvious correlation between numbers of vertebrae and rainfall, either annual or monthly. But Text-fig. 4, in which vertebrae are plotted against the mean normal temperature for December, shows a correlation very clearly, though what its significance may be remains to be discovered. It is, however, difficult not to suspect that the correlation may be due to direct cause and effect, since it has been shown experimentally that the numbers of meristic structures in poikilothermic animals may be changed by varying the temperature during development. Wade Fox (1948), for example, has shown that in a Garter Snake, the numbers of mid-body scale rows, and ventral and subcaudal scutes are higher in groups of individuals whose mothers were kept at higher temperatures during pregnancy. It has also been established that in fishes (e.g. Tåning, 1952, Lindsey, 1954) an increased temperature during the appropriate embryonic period will, in some species, result in an increased number of vertebrae, fin rays, etc. (and vice versa) within certain limits; a decrease in temperature below a certain point may also, sometimes, result in an increase of the meristic characters. Detailed information regarding the breeding season of *Aprasia* in all areas, together with temperature records of the egg sites will be necessary to establish that we are, in fact, dealing here with a thermo-plastic effect. In the meantime all that can be said is that there is evidence of a cline correlated with the temperature in summer, a time of year when breeding may be expected to occur. There is a discontinuity in the series and it is, therefore, legitimate to subdivide it at the discontinuity, treating the two parts as subspecies.

A. striolata, as already mentioned, also shows geographical variation in vertebral and mid-body scale numbers. It ranges from the south of Western Australia,

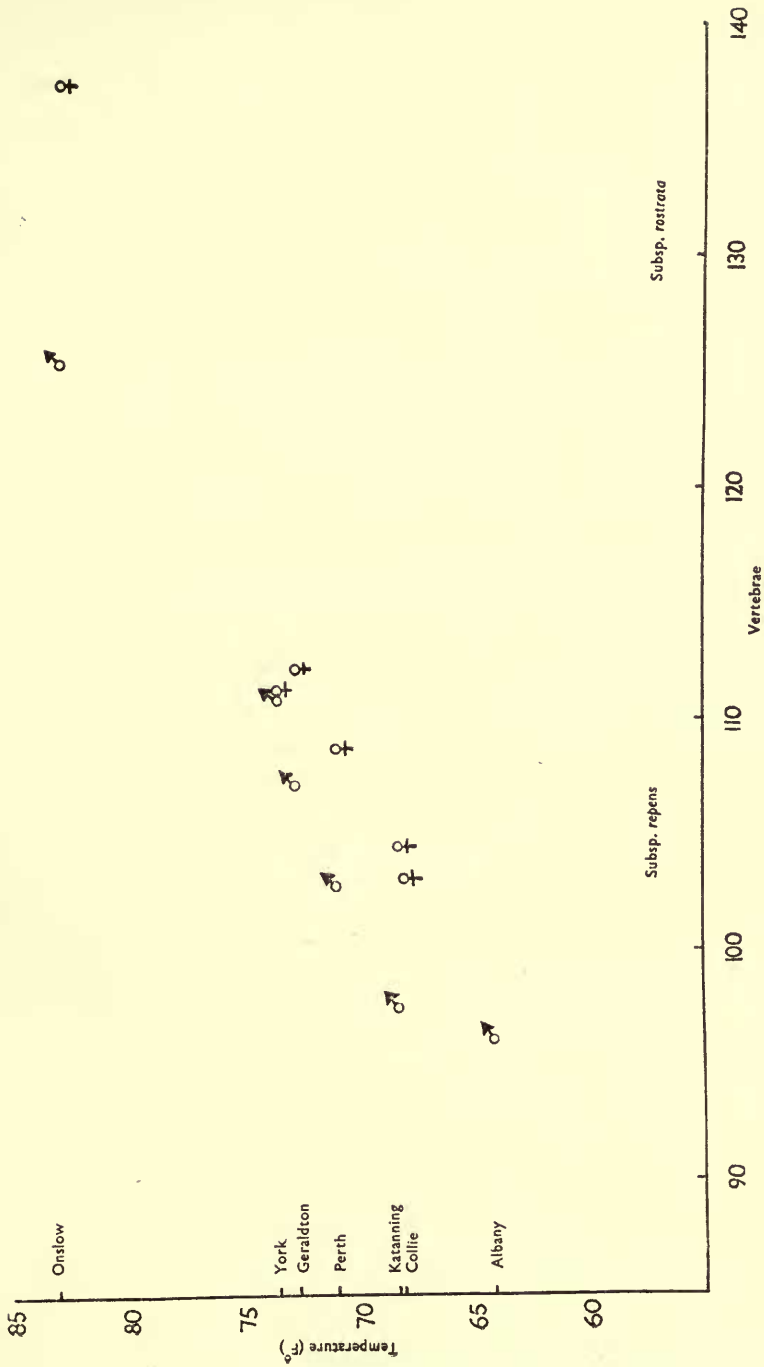


FIG. 4. *Aprasia repens*. Average numbers of presacral vertebrae in samples from areas around the climatological stations named, plotted against mean December temperatures.

where it is sympatric with *A. repens* in Albany, Plantagenet and Tambellup, across the south of the continent to western Victoria. In the west its vertebrae range from 88 to 94, there being no significant secondary sex difference, and the mid-body scales are constantly 12. In South Australia and Victoria the vertebrae range from 95 to 110 and 25% of the specimens seen have 14 scale rows. Again, as in *A. repens*, there appears to be some correlation with temperature, but not with rainfall, thus:

Station.	Vertebrae.	Scales.	Rainfall (annual average) (in.).	Temperature (mean, December) (° F.).
Albany	92.0 (11)	12	39.7	64.2
Katanning	91.3 (3)	12	19.4	68.3
Eyre (Nurina)	101.0	14	11.6	67.0
Wudinna ¹	99.0	14	15.0	71.0
Adelaide	101.4 (10)	12 or 14	21.0	70.7

¹ Climatic data estimated as intermediate between Port Lincoln and Port Augusta.

There is, however, inadequate information to establish the existence of temperature plasticity and, moreover, a marked discontinuity becomes obvious when the series is plotted (Text-fig. 5). So in the present state of knowledge the recognition of two subspecies is indicated.

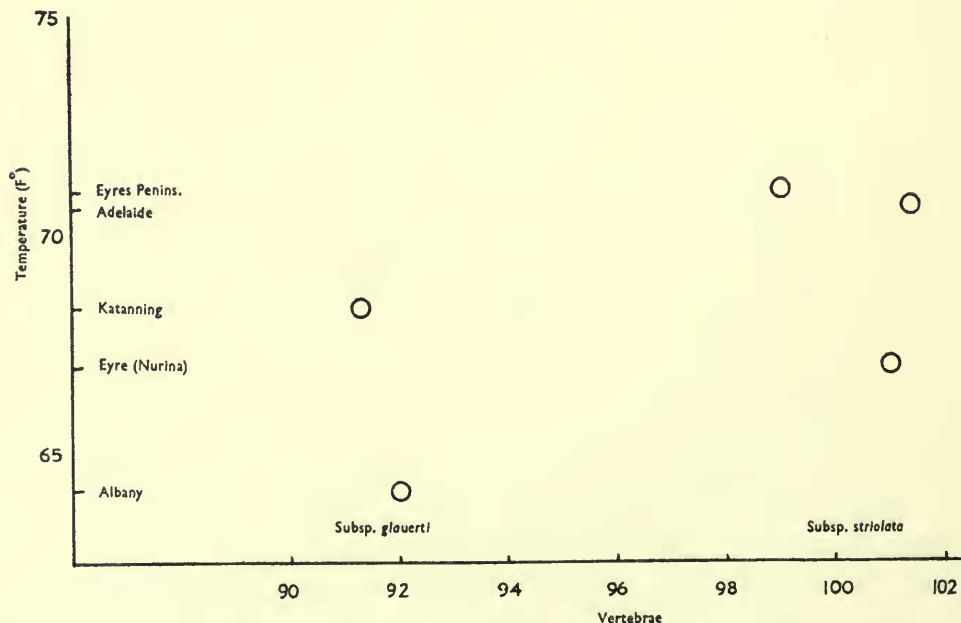


FIG. 5. *Aprasia striolata*. Average numbers of presacral vertebrae of local populations plotted against the mean December temperatures of the areas.

Only sixteen specimens of *A. pulchella* with definite localities have been examined, all from points between Albany and Geraldton. Within this restricted area there appears to be little variation; all the specimens have 14 scale-rows and the presacral vertebrae range between 96 and 98 in males (8) and from 102 to 105 in females (8). The type, a female without precise locality, has 104. The species may have a greater geographical range and there may be some geographical or temperature variation; one specimen seen (Sydney, No. 12529) is an immature male with a much higher number of vertebrae, 110. This specimen has no locality recorded against it in the registers of the Australian Museum, but formed part of a mixed collection mainly from the Northern Territory (Yirrikala Mission) and the northern parts of Western Australia.

The number of scales longitudinally is associated with the number of vertebrae and consequently shows the same geographical variation within each species. There are, however, differences between the species in regard to the number of scales in relation to the number of vertebrae, i.e. relative size of the scales, and the differences appear to be significant. The ratio of the number of ventral scales to the number of vertebrae varies as follows:

<i>A. pulchella</i>	(18)	1.44 to 1.59.	Mean	1.52	σ	0.049.
<i>A. striolata</i>	(28)	1.31 to 1.50.	„	1.43	σ	0.048.
<i>A. repens</i>	(48)	1.23 to 1.52.	„	1.35	σ	0.06.

Comparing the three on the criterion of the quotient of the difference of the means divided by the standard error of the difference of the means, the differences are all significant, thus:

$$(a) \frac{A. \textit{pulchella} / A. \textit{striolata} \bar{d}}{\sigma \bar{d}} = 6.4.$$

$$(b) \frac{A. \textit{striolata} / A. \textit{repens} \bar{d}}{\sigma \bar{d}} = 6.5.$$

$$(c) \frac{A. \textit{pulchella} / A. \textit{repens} \bar{d}}{\sigma \bar{d}} = 11.6.$$

A. striolata is almost exactly intermediate between the other two, *A. pulchella* having the smallest scales. Increase in scale-size is often accompanied by complete or partial elimination of some scales. In *Aprasia* this effect is manifest in the head region. In *A. repens*, with the largest scales, the post-ocular has been eliminated and the pre-ocular is much reduced in size compared with the other two species (c.f. Text-figs. 3, 6 and 7). No variation in this character has been observed.

The character of length of snout relative to size of eye can be appreciated by inspection, but is difficult to measure accurately. The method adopted was to measure the distance between the tip of the rostral and the anterior corner of the frontal as seen in plan projection on a plane parallel with that passing through the tip of the rostral and the centres of the eyes, using a camera lucida for the purpose. The eye diameter is that of the brill measured horizontally, i.e. excluding the ring of small scales that borders the "window". The method cannot be claimed to give a high degree of accuracy, but it does provide directly comparable figures

although the range of variation will almost certainly be exaggerated. Comparison between the subspecies shows no significant differences, thus :

(a)	<i>A. striolata striolata</i> (11).	Mean 1.67	σ 0.14	}	$\frac{d}{\sigma d}$	= 1.62.
	<i>A. striolata glauerti</i> (14).	„ 1.78	σ 0.16			
(b)	<i>A. repens repens</i> (65).	„ 1.96	σ 0.20	}	$\frac{d}{\sigma d}$	= < 1.
	<i>A. repens rostrata</i> (2).	„ 2.1	?			

Between species, however, the differences are marked and significant, thus :

<i>A. pulchella</i> (17).	Mean 1.45	σ 0.15.
<i>A. striolata</i> (25).	„ 1.74	„ 0.16.
<i>A. repens</i> (67).	„ 1.96	„ 0.20.
(a) <i>A. pulchella</i> / <i>A. striolata</i>	$\frac{d}{\sigma d}$	= 6.0.
(b) <i>A. striolata</i> / <i>A. repens</i>	„	= 5.5.
(c) <i>A. pulchella</i> / <i>A. repens</i>	„	= 11.9.

The character of the length of the rostral shield, as might be expected, is correlated with the length of the snout ; it shows no infraspecific variation that is certainly significant. As between species, however, the ratio of brill diameter to length of rostral* is :

<i>A. pulchella</i> (17).	Mean 3.90	σ 0.53.
<i>A. striolata</i> (25).	„ 1.80	σ 0.14.
<i>A. repens</i> (65).	„ 1.52	σ 0.18.

Comparing the differences of the means for significance :

(a) <i>A. pulchella</i> / <i>A. striolata</i>	$\frac{d}{\sigma d}$	= 16.2.
(b) <i>A. striolata</i> / <i>A. repens</i>	„	= 8.8.
(c) <i>A. pulchella</i> / <i>A. repens</i>	„	= 19.0.

Thus, it seems to be established that infra-specific variation occurs mainly, if not exclusively, in meristic characters—the numbers of vertebrae and scales. Non-meristic characters such as the length of the snout relative to the eye (and the associated character of the relative proportions of the rostral shield), the presence or absence of a post-ocular shield, and relative scale size are significantly different between the samples that are believed to represent bio-species, but show no significant geographical variation within these groups.

SYNONYMIES AND DESCRIPTIONS

Aprasia striolata striolata Lütken

Aprasia pulchella var. *striolata* Lütken, 1863, *Vidensk. Medd. Kbh.* 1862 : 300, pls. 1-2, figs. 3-3c.

Aprasia pulchella var. *lineolata* Lütken, 1863, loc. cit.

Aprasia octolineata Peters, 1864, *Monatsber. Ak. Berlin*, 1863 : 233.

Aprasia pulchella, Günther, 1873 *Ann. Mag. nat. Hist.* (4) 12 : 145 (part). Günther, 1875, *Zool.*

* (Measured in plan projection.)

Erebus and Terror, 2: 10 (part). Boulenger, 1885, *Cat. Lizards Brit. Mus.* 1: 246 (part). McCoy, 1888, *Prodrom. Zool. Victoria*, 17: 233, pl. 161, fig. 1. Lucas & Frost, 1894, *Proc. roy. Soc. Vict.*, n.s., 5: 340. Lucas & le Souëf, 1909, *The Animals of Australia* (Melbourne): 219 (part). Werner, 1912, *Das Tierreich*, 33: 25 (part), fig. 5. Zietz, 1920, *Rec. S. Aust. Mus.* 1: 193 (part). Kinghorn, 1923, *Rec. Aust. Mus.* 14, 2: 130 (part), figs. 7-9. Kinghorn, 1926, *Rec. Aust. Mus.* 15: 63, fig. 18. Kershaw, 1927, *Vict. Nat.* 43: 341. Waite, 1929, *Rept. and Amph. of South Australia* (Adelaide): 95, figs. 69, 70.
Ophioseps nasutus (non Bocage), Jensen, 1901, *Vidensk. Medd. Kbh.* 1900: 317, pl. 3.
Ophioseps nasutus, (non Bocage), Fry, 1914, *Rec. W. Aust. Mus.* 1: 181 (part). Kinghorn, 1923, *Rec. Aust. Mus.* 14, 2: 128 (part), figs. 4-6. Kinghorn, 1926, op. cit., 15: 62, fig. 17.

Snout projecting and rounded, its length 1.5 to 2.0 times as long as the horizontal diameter of the brill (mean 1.67, σ 0.14). Rostral well visible from above, its length contained 1.8 to 2.0 times in the length of the brill (mean 1.90, σ 0.07). A suture normally connects the nostril with the suture between the first and second labials so that the nasal and the second labial are in contact; in one specimen only of the fifteen examined are these two shields separated. A small postocular separates the fourth labial from the supraocular. Premaxillary teeth may be present, though small, in females; they are constantly present, and much larger, in males. Scales in 12 (80%) or 14 (20%) longitudinal rows at mid-body; from 140 to 155 scales, approximately, in a straight line from the mental shield to the vent in the proportion of 1.38 to 1.50 (mean 1.43, $\sigma = 0.034$, n. 13) per vertebra. Presacral vertebrae number 98 to 104 in males (5 counted) and 95 to 110 in the nine females. A well defined colour pattern of dark lines or rows of dots is usually present on the back. The largest female examined measures 133 mm. from snout to vent and the largest male 107 mm.

This subspecies appears to range from western Victoria westwards to the Nurina Division of Western Australia. The reasons for its recognition have been discussed above. The material examined includes the immature specimens which Jensen misidentified as *Ophioseps nasutus* Bocage. The variation in the more important taxonomic characters is as follows:

Museum No.	Locality.	Sex.	Length.	Scales.	Verte- brae.	Snout.		Eye
						Eye	Rostral.	
Cop. R. 50.2 . . .	Hochkirk, Vict.	?	57	12	100	1.7	1.8	
Sydney 11759 . . .	Jeparit, Vict.	♀	?	12	?	?	?	
" 11760 . . .	" "	♀	?	12	95	?	?	
B.M. 1902.7.30.8 . . .	Renmark, S.A.	♀	79	12	102	1.5	1.9	
" 1902.5.30.10 . . .	" "	♀	110	14	109	1.7	1.9	
" 1902.5.30.11 . . .	" "	♀	109	14	101	2.0	1.8	
" 1902.5.30.12 . . .	" "	♂	100	12	98	1.5	2.0	
" 1902.5.30.13 . . .	" "	♂	95	12	101	1.7	2.0	
" 1862.7.19.4 . . .	S. Australia	♂	102	12	104	1.6	1.9	
" 1862.7.19.5 . . .	" "	♀	118	12	104	1.6	1.9	
" 1862.7.19.6 . . .	" "	♂	110	12	100	?	?	
Sydney 14382 . . .	Wudinna, S.A.	♂	107	14	99	?	?	
" 3466 . . .	?	♀	115	12	102	1.7	1.9	
B.M. 46.5.2.14 . . .	?	♀	133	12	110	1.6	1.9	
Perth R. 5280 . . .	Eyre, Nurina, W.A.	♀	113	14	101	1.8	1.8	

Aprasia striolata glauerti subsp. nov.

(Text-fig. 3A)

Snout projecting and rounded (Text-fig. 3A), its length 1.6 to 2.1 times as long as the horizontal diameter of the brill (mean 1.78, $\sigma = 0.16$). The rostral is well visible from above, its length being contained 1.5 to 1.9 times in the length of the brill, the mean being 1.70 and $\sigma 0.14$. The condition of the nasal suture is similar to that of the eastern race, but two specimens of the fifteen are asymmetrical and have the nasal separated from the second labial on one side; in one specimen the suture is incomplete and fails to reach either the interlabial or the naso-prefrontal suture. Mid-body scale rows are constantly 12 and there are from about 120 to 140 from the mental shield to the vent in the proportion of 1.31 to 1.49 (mean 1.43, $\sigma 0.058$, n. 15) per vertebra. Presacral vertebrae number 88 to 93 in males (7) and 91 to 94 in females (8). Premaxillary teeth present in both sexes, but smaller and sometimes absent in females. Straw coloured above and beneath, sometimes with obscure darker markings suggesting dusky lines on the back. The largest male measures 109 mm. from snout to vent and the largest female 115 mm.

The type series is from the "road districts" of Albany, Plantagenet and Tambellup, as listed below, the first mentioned being the holotype.

Museum No.	Locality.	Sex.	Length.	Vertebrae.	Snout		Eye	
					Eye	Rostral.		
Perth 10949 . .	Albany	♂	79	93	1.9	1.6		
" 6782 . .	"	♀	89	92	1.7	1.5		
" 6782 . .	"	♂	89	88	1.6	1.8		
" 6782 . .	"	♀	89	91	1.9	1.7		
" 6782 . .	"	♀	95	94	1.9	1.5		
" 6782 . .	"	♂	97	93	1.8	1.9		
" 6782 . .	"	♀	98	93	1.7	1.8		
" 10950 . .	"	♀	115	92	2.1	1.6		
" 10951 . .	"	♀	92	91	1.9	1.6		
B.M. 1911.12.18.3 .	"	♀	108	93	1.7	1.7		
Perth 7214 . .	Narrikup	♂	84	93	2.0	1.9		
Sydney 12305 . .	Tambellup	♂	79	90	1.6	1.9		
" 12305 . .	"	♂	88	92	1.6	1.8		
" 12305 . .	"	♀	92	92	1.6	1.9		
" 3468 . .	[" Australia "]	♂	109	92	?	?		

Aprasia pulchella Gray

(Text-figs. 3B and 6)

Aprasia pulchella Gray, 1839, *Ann. Nat. Hist.* 2: 332. Gray, 1841, in Grey, *Travels in Australia*, 2: 428, 438, pl. 4, fig. 2. Gray, 1845, *Cat. Lizards Brit. Mus.*: 68 (part). Günther, 1873, *Ann. Mag. nat. Hist.* (4) 12: 145 (part). Günther, 1875, *Zool. Erebus & Terror*, 2: 10 (part). Boulenger, 1885, *Cat. Lizards Brit. Mus.* 1: 246 (part). Lucas & le Souéfi, 1909, *The Animals of Australia*, (Melbourne): 219 (part). Zietz, 1920, *Rec. S. Aust. Mus.* 1: 193 (part). Kinghorn, 1923, *Rec. Aust. Mus.* 14, 2: 130 (part). Kinghorn, 1926, *Rec. Aust. Mus.* 15: 63 (part). Loveridge, 1934, *Bull. Mus. comp. Zool. Harv.* 77: 316.

- Ophioseps nasutus* Bocage, 1873, *J. Sci. math. phys. nat. Lisboa*, 4: 232. Werner, 1912, *Das Tierreich*: 33: 25. Fry, 1914, *Rec. W. Aust. Mus.* 1: 181 (part). Kinghorn, 1923, *Rec. Aust. Mus.* 14, 2, 128 (part).
- Ophiopsiseps nasutus*, Boulenger, 1887, *Cat. Lizards Brit. Mus.* 3: 436.
- Aprasia brevirostris* Werner, 1909, in Michaelsen & Hartmeyer, *Die Fauna südwest-Austral.* 2, 16: 266, fig. 2.

Snout slightly prominent and bluntly rounded (Text-figs. 3B and 6), its length 1.1 to 1.8 times the length of the brill (mean 1.45, σ 0.15). The portion of the rostral visible from above is less extensive than in any other species, its length being contained 3.1 to 5.0 times in the brillar length (mean 3.90, σ 0.53). No suture between the nasal and first labial shield, though in the holotype there is a vestige on the nasoprefrontal suture (Text-fig. 6). A postocular separates the fourth upper labial from the supraocular. Mid-body scale rows 14; from 145 to 170 scales, approximately, on the mid-line between the mental shield and the vent in the proportion of 1.44 to 1.59 (mean 1.52, σ 0.049; n. 18) per vertebra. Presacral vertebrae 96 to 110 in males (9) and 102 to 105 in females (9); the possibility of geographical variation in this character has already been discussed. Pre-maxillary teeth absent in females. Pale brown above with indefinite dusky linear markings on the dorsal scales which can produce a lineolate appearance; on the head the dark markings are more irregular and produce a vermiculate appearance. The largest male examined measures 108 mm. from snout to vent and the largest female 124 mm.

This species is known with certainty to occur from Albany to Geraldton.

Although Boulenger (1885) lists two specimens as "types" of *A. pulchella*, there is nothing in Gray's original description to indicate that he had more than one specimen whose dimensions are given as $2\frac{3}{4}$ in. from snout to vent with a tail of $1\frac{3}{4}$ in. Only one of Boulenger's specimens, the one listed below as B.M. 1946.8.30.93,

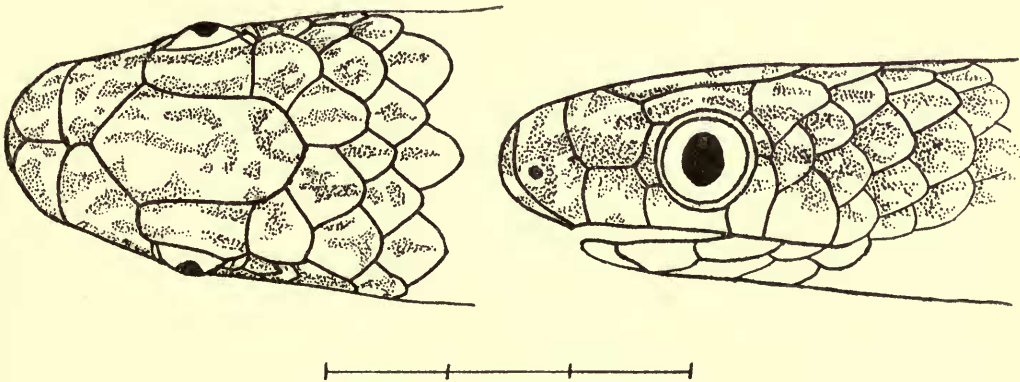


FIG. 6. *Aprasia pulchella* Gray. Holotype female.

approximates to these dimensions (snout to vent 2.8 in., tail 1.75 in.) and has vermiculate head-markings (c.f. Text-fig. 6) as figured by Gray in 1841. The only doubts on the matter arise from the facts that (1) the original description states that the nostril lies "in the suture between the top of the first labial and anterior frontal plate" and (2) Günther in 1873 stated that all the specimens then in the British Museum had only 12 mid-body scales. In the specimen now regarded as the type the first labial is fused with the shield above it and there are 14 scale rows. Günther was patently in error, as was Boulenger (1885), also, when he failed to detect more than 12 scale rows and it seems likely that Gray, using only a hand lens, was misled by the vestige of a suture.

Thanks to the courtesy of Professor Jorge the holotype of *Ophioseps nasutus* Bocage has been examined and compared with the other specimens listed. Unfortunately the specimen is in very poor condition; it is in four fragments, breaks occurring after the ninth vertebra, in front of the nineteenth presacral, and immediately behind the pelvic girdle; the tail tip is also wanting and the scales of the upper surface of the head are very badly abraded, so that their limits can only be determined with difficulty and a little uncertainty. It is also likely that the specimen has been partially desiccated at some time, since the cranium was full of air and the whole specimen measures only 73% of its pristine length (head and body fragments 95 vice 133 mm. and tail 38 vice 52 mm.).¹ Nevertheless, despite these defects, a sufficient number of characters can be deciphered or measured to make it virtually certain that the species involved is the same one which Gray had previously named *Aprasia pulchella*. Thus, for comparison with the characters of the species:

	<i>O. nasutus</i> (Type).	<i>Aprasia pulchella</i> .
Suture from nostril . . .	Absent .	Absent
Snout length/brill diam. .	1.42 .	Mean 1.45
Brill diam./rostral length .	3.7 .	" 3.9
Postocular	Present	Present
Mid-body scales	14 .	14
Scales/vertebrae	1.57 .	Mean 1.52

As noted above, the skull is visible dorsally and the ratio of frontal to nasal length (1.56) is similar to that in an example of *A. pulchella* (1.50). The presacral vertebrae number 89, but it is certain that a number have been lost from the ends of most of the fragments (one was found loose) and no significance can be attached to the number. The sex cannot be determined since, although no post-cloacal bones are present, there is a clear indication of the loss of at least 4 anterior caudal vertebrae. The first of the tail vertebrae has a well-defined fracture-plane through its centrum and so cannot be one of the most anterior caudal vertebrae which possess no such split (Pratt: 184); in the numerous X-ray photographs of *Aprasia* that have been examined the fracture-plane is not evident anterior to the fifth to seventh caudal.

¹ The reduction cannot be due to the loss of a single large fragment of 52 mm. because when the tail and the head-plus-body are considered separately each is shorter than originally in the same proportion.

The specimens examined and their characters are :

	Museum No.	Locality.	Sex.	Length.	Verte- brae.	Snout. Eye	Eye Rostral.
Perth	10954	Albany	♀	117	102	1.6	3.2
"	10955	"	♂	92	98	1.6	3.8
"	2371	Mt. Baker	♀	109	103	1.4	3.1
"	10711	Boddington	♂	95	96	1.5	5.0
"	10712	"	♂	108	97	1.6	4.0
"	642	Wagin	♀	114	104	1.4	4.2
"	3873	Lowden	♂	74	96	1.5	3.3
"	1984	Mt. Helena	♀	?	104	1.8	3.6
"	5994	Statham	♂	99	98	1.5	4.0
"	4629	Huntley	♂	86	97	1.4	4.5
"	3342	Darlington	♀	106	105	1.4	4.0
"	4629A	Guildford	♀	104	103	1.4	3.5
M.C.Z.	24460	Mundaring Weir	♂	—	98	1.3	—
Perth	3409	Upper Swan River	♀	124	105	1.5	3.8
B.M.	—	Swan River	♀	106	?	1.1	3.6
M.C.Z.	24467	Geraldton	♀	—	103	1.6	—
"	24468	"	♂	—	98	1.5	—
B.M.	1946.8.30.93	W. Australia	♀	72	104	1.2	3.5
Sydney	6553	?	?	115	?	1.4	4.7
"	12529	?	♂	62	110	1.4	4.5
Mus. Bocage	.	" Australia "	?	95+	89+	1.42	3.7

Aprasia repens repens (Fry)

(Text-fig. 3c)

- Aprasia pulchella* (part), Gray, 1845, *Cat. Lizards Brit. Mus.*: 68. Günther, 1875, *Ann. Mag. nat. Hist.* (4) 12: 145. Günther, 1875, *Zool. Erebus & Terror*, 2: 10. Boulenger, 1885, *Cat. Lizards Brit. Mus.* 1: 246. Werner, 1909, in Michaelsen & Hartmeyer, *Die Fauna südwest Austral.* 2, 16: 266. Lucas & le Souëf, 1909, *The Animals of Australia* (Melbourne): 219. Werner, 1912, *Das Tierreich*, 33: 25. Zietz, 1920, *Rec. S. Aust. Mus.* 1: 193.
- Ophioseps repens* Fry, 1912, *Rec. W. Aust. Mus.* 1: 178, fig.
- Aprasia repens*, Kinghorn, 1923, *Rec. Aust. Mus.* 14, 2: 132, figs. 10–12. Kinghorn, 1926, *Rec. Aust. Mus.* 15: 64. Loveridge, 1934, *Bull. Mus. comp. Zool. Harv.* 77: 317.
- Lialis repens*, Kinghorn, 1926. tom. cit. fig. 19.

Snout strongly projecting (Text-fig. 3c), its length 1.4 to 2.5 times as long as the brill (mean 1.96, σ 0.20). Rostral well visible from above, its length contained 1.0 to 2.4 times in the brillar diameter (mean 1.52, σ 0.18). A suture connects the nostril with the anterior border of the prefrontal so that the first labial and the prefrontal are in contact; in two specimens the four shields (nasal, prefrontal, first labial, second labial) meet at a point and in another example the two sides are not symmetrical the nasal being in contact with the second labial on the right side but separated from it on the left. There is no postocular, the fourth labial reaching the supraocular. Premaxillary teeth absent in females. Scales in 12 (75 specimens) or 14 (1 specimen) rows at mid-body and between 125 and 165, approximately in a median line from the mental shield to the vent in the proportion of 1.23 to 1.52 (mean 1.35; σ 0.06; n. 46) per vertebra. Presacral vertebrae

96-112 in males and 98-116 in females, there being geographical, possibly temperature correlated, variation as discussed above. The ground colour is pale straw, above and below, often with ill-defined dark longitudinal lines or rows of dots on the back and especially on the flanks; head sometimes with dark markings; upper lip and throat chrome yellow; tail red or yellow. The largest male examined is 150 mm. from snout to vent and the largest female 165 mm.

The subspecies ranges from Albany to Victoria (W.A.) and possibly further north. Werner (1909) records a specimen in the Perth Museum as from Shark Bay, but there is no present record of such a specimen. The only possibility is specimen R.11360, a male which bears a label "M & H" (= Michaelsen and Hartmeyer); but Werner's record is not listed as having been obtained at any of the stations where Michaelsen and Hartmeyer worked and which are all numbered. In addition its vertebral count (104) is much more compatible with an origin near Perth.

The material examined contained these specimens:

Museum No.	Locality.	Sex.	Length.	Verte- brae.	Scales.	Snout. Eye.
Perth 10952 . . .	Albany	♂	73	96	12	1.8
" 10953 . . .	"	♂	98	96	12	2.1
B.M. 1931.7.1.139 . . .	Mt. Toolbrunup	♂	95	96	12	1.7
Perth 2868 . . .	Tambellup	♀	104	104	12	1.7
" 2869 . . .	"	♂	83	99	12	1.9
" 2870 . . .	"	♀	93	103	12	1.9
" 2871 . . .	"	♀	95	103	12	1.8
" 2872 . . .	"	♀	95	104	12	1.8
" 10692 . . .	Borden	♀	116	106	12	1.8
" 433A . . .	Dumbleyung	♂	82	97	12	2.1
" 433B . . .	"	♀	103	105	12	2.1
" 373 . . .	"	♀	105	106	12	2.3
Sydney 8015 . . .	"	♀	101	104	12	?
Perth 10246 . . .	Williams	♀	107	108	12	2.0
" 10322 . . .	Bunbury	♀	95	98	12	1.9
" 10895 . . .	West Midland	♂	82	101	12	2.1
" 10894 . . .	" "	♀	90	107	12	1.9
" 10893 . . .	" "	♀	82	111	12	1.8
" 4173 . . .	Midland	♀	93	107	12	2.1
" 766 . . .	Midland Junction	♀	107	110	12	2.0
" 3734 . . .	Rottneest Isld.	♂	62	107	12	2.3
" 3759 . . .	" "	♂	?	92	12	2.1
" 3765 . . .	" "	♀	63	111	12	1.9
" 4582 . . .	" "	♀	109	113	12	2.3
M.C.Z. 33027 . . .	" "	♂	—	110	12	—
" 33028 . . .	" "	♀	—	113	12	—
" 33029 . . .	" "	♀	—	109	12	—
" 33031 . . .	" "	♀	—	110	12	—
" 33032 . . .	" "	♀	—	110	12	—

Museum No.	Locality.	Sex.	Length.	Verte- brae.	Scales.	Snout. Eye
Perth 4373	East Perth	♂	107	105	12	2.0
B.M. 69.5.25.18	Perth	♂	100	?	12	2.3
Perth 3347	"	♂	96	105	12	2.0
" 2596	"	♂	87	101	12	1.9
" 1742	"	♀	104	106	12	2.1
" 6944	"	♂	76	103	12	2.0
" 631	"	♀	52	?	12	2.0
" 2251	"	♀	98	105	12	1.9
Perth 9664	Rivervale	♂	88	101	12	2.3
" 9665	"	♂	55	103	12	?
" 2837	Gooseberry Hill	♀	87	114	12	2.1
" 8745	" "	♀	110	114	12	1.7
" 8185	Claremont	♂	78	100	12	2.0
" 9093	Nedlands	♂	80	102	12	2.0
" 9094	"	♂	71	102	12	1.7
" 5344	"	♀	58	104	12	2.0
" 123	Cottesloe	♂	105	106	12	2.1
" 7405	Applecross	♂	80	95	12	2.2
" 7406	"	♀	72	104	12	1.8
" 7390	"	♂	68	99	12	2.1
" 5310	Bayswater	♂	92	108	12	2.1
" 8721	"	♀	98	108	12	1.8
" 10208	"	♀	102	108	12	2.0
" 2150*	Bassendean	♀	103	107	12	2.0
" 1374	Leederville	♀	102	113	12	2.0
" 5351	Maylands	♀	71	109	12	2.0
" 2397	Mt. Lawley	♂	82	106	12	1.7
" 4186	" "	♂	57	101	12	1.5
" 707	E. Freemantle	♀	47	102	12	1.4
" 4383	" "	♀	106	106	12	1.7
M.C.Z. 24427	Balcatta Beach	♂	—	105	12	—
Perth 4356	Stoneville	♀	102	108	12	1.9
" 4357	"	♀	63	?	12	1.6
Sydney 9138	Mundaring	♀	75	106	12	2.1
Perth 5492	Northam	♀	123	116	12	2.0
" 8891	"	♂	92	112	12	1.6
" 4913	"	♂	102	112	12	1.9
" 6927	Bakers Hill	♂	93	108	12	2.0
" 9222	Lomos	♀	80	106	12	2.0
" 1730	Newmarracarra (Vict.).	?	?	?	12	2.2
" 5064	Eradu (Vict.)	♂	60	109	14	2.5
M.C.Z. 24458	Geraldton	♀	—	112	12	—
" 24459	"	♂	—	105	12	—
B.M. 43.5.19.86	W. Australia	♂	85	?	12	2.0
Perth 11360	?	♂	60	104	12	2.0

* This specimen is ovigerous.

Aprasia repens rostrata subsp. nov.

(Text-fig. 7)

Aprasia sp. Hill, 1955, *Proc. Linn., Lond.* 165, 2: 115.

Holotype a male, collected 17.viii.52 on Hermite Island and allotype a female collected on the same island 22.v.52.

Snout very strongly projecting (Text-fig. 7) its length 2.0 times and 2.2 times as long as the diameter of the brill in male and female respectively. Rostral shield drawn out posteriorly so that the length of the portion visible from above is contained 0.9 (♂) and 0.8 (♀) times in the brillar length. The suture running backwards from the nostril meets the suture between the first and second labials in such a position

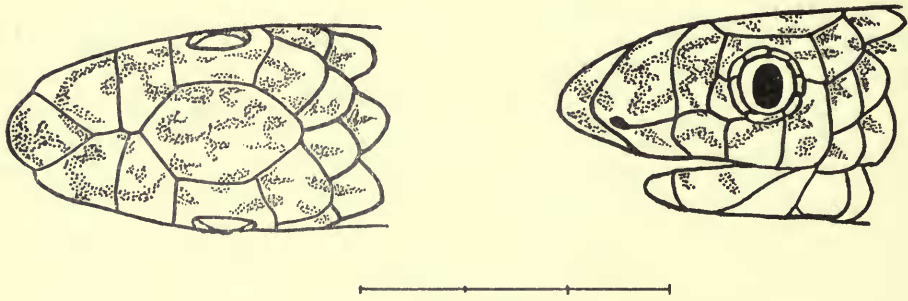


FIG. 7. *Aprasia repens rostrata* subsp. nov. Allotype female.

that these two labials, the nasal and the prefrontal meet at a point. No post-ocular shield, the supraocular produced ventrally to make contact with the fourth labial. Premaxillary teeth present in the male but absent in the female. Scales in 14 longitudinal rows at mid-body. Scales on the mid-line between the mental shield and the vent are about 175 in the male and 190 in the female, counted to the nearest five. Presacral vertebrae 125 in the male and 137 in the female.

Pale brown above and white beneath. A broad darker lateral band on the sides of the neck which breaks up posteriorly into three fine brown lines. Three additional fine brown lines on the nape, but the mid-dorsal region of the body not lined; a single mid-dorsal dark line along the tail. Another brown line on each side of the belly. Head vermiculate.

Dimensions :

♂. Snout to vent 99 mm. ; tail 65 mm. (incomplete).

♀. " " " 109 mm. ; " 13 mm. (").

ACKNOWLEDGMENTS

Thanks are due to Sir William Penney who, despite his many preoccupations with the major objects of the expedition to the Monte Bello Islands, arranged for collections of the fauna and flora of the islands to be made, and to Surgeon Commander G. Wedd, R.N., who organized and supervised these activities. The resulting material touched off the present investigation, but no progress could have been made without the assistance of Mr. L. Glauert, Mr. J. R. Kinghorn, Mr. F. W. Braestrup and Mr. A. Loveridge, who have been most generous in lending comparative material from their museums at Perth, Sydney, Copenhagen and Harvard. The author is also grateful to his colleagues Mr. N. B. Marshall, and Mr. D. W. Tucker, for help with ichthyological references, and to Mr. P. E. Purves for the large number of X-ray photographs that had to be taken.

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